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Agricultural Higher Education in the 21st Century
A global challenge in knowledge transfer to meet world demands for food security and sustainability

Conference report and conclusions

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I – Background and goal of the Conference

A major challenge in the 21st Century is that of doubling food production under more restrictive environmental conditions. The agricultural knowledge transfer system, particularly higher education, has a responsibility to adapt and respond to this and other challenges. The obstacles, context, and responsibilities faced by higher education institutions around the world vary widely. The goal of the conference was to convene top-level experts from different areas of the world to foster discussion and prepare recommendations for the future development of curricula in the Agricultural and Life Sciences.

II – Organization of the Conference

The conference was held on 15-17 June 2015, in Zaragoza, Spain, organized by the Mediterranean Agronomic Institute of Zaragoza – International Centre for Advanced Mediterranean Agronomic Studies (IAMZ-CIHEAM), the Centre for Agricultural Research – Hungarian Academy of Sciences (MTA-ATK), the Union for the Mediterranean (UfM), the Association for European Life Science Universities (ICA) and the Global Confederation of Higher Education Associations for Agricultural and Life Sciences (GCHERA), with the sponsorship of the OECD Co-operative Research Programme on Biological Resource Management for Sustainable Agricultural Systems.

III – Participation

Participation: More than 80 participants from 28 Countries (Albania, Algeria, Australia, Belgium, Canada, China, Costa Rica, Egypt, France, Holland, Hungary, India, Ireland, Israel, Japan, Lebanon, Malta, Mexico, Morocco, Poland, Portugal, Romania, Spain, Switzerland, Tunisia, Turkey, United Kingdom, United States of America) attended the conference, representing agricultural higher education institutions and other stakeholders in agricultural curricular reform. Most of par-

ticipants were academic authorities (rectors, deans and directors) and professors of 35 Agricultural Universities and Faculties of the represented countries. Eleven participants were directives and staff of four international organisations (OECD, CIHEAM, Union for the Mediterranean, Commonwealth of Learning). Eight participants represented seven national and international associations involved in Agricultural Higher Education. Three researchers from public research institutions, 2 administrations high officers, and 2 private firms' executives also attended the conference. Some MSc students of IAMZ-CIHEAM also participated in the conference. The list of participants and their institutional affiliations is available in the last section of this volume.

IV – Conference programme

The conference had thirty conference speakers, chairpersons, and facilitators from seventeen countries. The list of presenters is available in the Conference programme included at the end of this volume. Conference coordinators organized an interactive conference where all presentations had time allocated for questions and answers, and all participants were able to engage in three formal general discussions focused on the analysis and recommendations for future development of curricula in the agricultural and life sciences, as well as informal discussions and networking for sustained collaboration beyond the conference.

1. Conference sessions

Five consecutive sessions, each building on each other, represented the backbone of a programme with 28 presentations and three general discussions. Throughout the sessions, participants analyzed the global challenges for agriculture and higher education in the 21st Century, the drivers for agricultural research and education, and the role of higher education to meet world demands for food security and sustainability. Representatives from around the world (Asia, Oceania, Latin America, North America, Europe, and Northern African countries) reviewed regional challenges and needs, described the educational models adopted in their institutions, and discussed their accomplishments and successes, as well as the barriers for further advancement. Through case studies, presenters analyzed curriculum needs, and offered many examples of innovation, growth, and success in adapting the agricultural curricula to different global, regional, and institutional challenges and contexts. These case studies ranged from non-traditional educational models, open universities and distance education, developing the industry ready graduate, to transformative agricultural education; addressed the needs for technology transfer skills and sustainability competence in curricula, the requirements of the private sector in agricultural higher education, and the role of new biotechnologies in agricultural curricula; and studied the role of quality assurance and program accreditation in supporting development of innovative agricultural curricula. Finally, participants addressed globalization and international alliances, including a model for private enterprise commitment to higher education (Universitas Banco de Santander), joint degrees, and the CIHEAM-IAMZ international cooperative model (Romagosa & Cerezo, 2015). The full conference programme, with presenters' names and affiliations, is included in the last section of this volume. The titles of the five sessions were as follows:

- Opening session.
- Session I: Challenges for agriculture in the XXI Century.
- Session II: Are current agricultural educational models suitable to meet global challenges?
- Session III: Addressing the needs and challenges for innovation in agricultural curricula.
- Session IV: Globalization and international alliances.

2. General discussions

Three general discussions helped connect all presentations and sessions, and gave conference attendees the opportunity to participate in the dialogue, present their ideas, and contribute to the conference.

The following probing questions were used as catalyzers for the discussions, and were meant to integrate the corresponding session presentations and build upon each other.

- How should agricultural higher education adapt to the key challenges of agriculture in the 21st Century?
- What are agricultural higher education programs not doing well to meet these challenges?
- What are some characteristics of programs that are being successful in addressing these challenges?
- To address the challenges of the 21st Century in the bioeconomy[1], graduates of agricultural higher education should be holistic thinkers and effective problem solvers. Are our current curricula fit for this purpose, or what has to change?
- How do we balance between the need for breadth and depth of knowledge within disciplines, and the need to develop students' high level cognition (analysis, evaluation, and synthesis).
- Changing the emphasis from knowledge and understanding to higher order cognitive learning outcomes (analysis, evaluation, and synthesis): Is there a need for change? What are the hurdles in your faculty? What are some success examples?
- What are the indicators that agricultural universities can use to measure progress in curricular development to deliver graduates to address the challenges of the 21st Century?

For each discussion, participants were given several opportunities and tools to provide feedback at the individual and team levels. The probing questions for the discussions were provided to participants individually and in writing at the beginning of each session (in the morning), and displayed in boards at the side walls of the conference room. Attendees were encouraged throughout the day to contribute their individual responses by writing them in cards, and posting them in the conference boards. The posts further stimulated dialogue and provided a good segue to the general discussions at the end of each day.

The general discussion sessions started with small group discussions. This activity was dynamic and engaging from the start because all participants had already had the opportunity to reflect on their own responses to the questions throughout the day. The teams had the opportunity to add their group responses in the conference boards. After this initial exercise, there was a general discussion facilitated by Simon Heath and Maria Navarro.

The participant contributions (individual, team, and general discussions), both in writing and verbally as part of the discussion, were recorded, transcribed, and analyzed for content by the discussion facilitators, after the end of the conference. The resulting themes were integrated into the major highlights from the conference presented in this document.

[1] The bioeconomy encompasses the production of renewable biological resources and the conversion of these resources and waste streams into value added products, such as food, feed, bio-based products and bioenergy.

V – Major highlights from the presentations and discussions

All attendees are originators and architects of some of the materials presented in this report. A heartfelt thank you is extended to all participants, presenters, conference chairs, coordinators, interpreters, and organizers. Many concepts reported in this document were mentioned many times, by several participants. They turned up in individual presentations, general discussions, small group conversations, or anonymous posts. Thus, it is not possible in this report to give credit individually to all participants for their comments, opinions, or ideas. However, we have tried to cite, when possible, the original conference contributor of distinct concepts, and encourage the reader to refer to their manuscript for further detail.

1. Challenges for Agriculture and Higher Education in Agriculture in the 21st Century

In 2003 Nobel Laureate Richard Smalley developed a list of humanity's top ten problems for the next 50 years: energy, water, food, environment, poverty, terrorism and war, disease, education, democracy, and population (Smalley Institute, 2008). Similar challenges were addressed by conference participants. As presented by Arjen Wals (2015), citing Gibson (2013), these are "wicked" problems that are arduous to define, are not well understood, have ambiguous and conflicting interpretations, and shift with time. Challenges mentioned often during the conference included a growing population; increased demands, pressure, and degradation of resources (soil, biodiversity, energy, water); health and food-related issues and paradoxes (food insecurity, nutritional deficiencies, obesity, food waste); green house gas emissions and global warming (and impact on climate change, variability, and extreme weather events), and other environmental challenges.

Concomitantly, Higher Education and the agriculture sector are facing additional changes and threats to their success. Many presenters argued that students and today's graduates in many institutions are not prepared to address these grand challenges; interest in agriculture studies has declined in the last decades; there is a general erosion of trust in science, inaction, and powerlessness (Wals, 2015); there is a declining role and investment of the public sector in agricultural innovation (Kennelly, 2015); additional societal changes such as globalization, urbanization, technological change, unemployment, migration, conflict, education, etc. greatly affect economic and social sustainability of both consumers and producers; value chains are increasingly complex; and markets, regulations, policies, and governance structures are inappropriate or ineffective, further hindering the efficient use of natural resources (Moreddu, 2015).

2. Response of Higher Education in Agriculture

In the words of John Kennelly (2015), a key factor in maintaining relevance is to evolve to respond to changing circumstances. Conference participants agreed that Higher Education must respond to all these challenges by focusing on adapting practices, processes, and products to improve productivity, efficiency, and sustainability of agriculture to produce more food, healthier food, in less land and with lower impacts on the environment, hence the term "ecological / sustainable intensification" (Minguez & Connor, 2015). Additional foci included universal access to food, as well as adapt to, and mitigate of, climate change.

Thus, according to Minguez and Connor (2015), key features of agricultural production will be increasing application of science and technology, and management by measurement, recording, and analysis of activities and inputs, which will require workers ranging from unskilled labour to highly-qualified academic researchers.

To do that, Higher Education must better understand the challenges it faces, and appropriately identify social, economic, environmental, educational, historical, emotional, technological, and political factors; and clarify and differentiate local, regional, and global context, needs, focus, mission, vision, values, and goals.

3. A new paradigm for the development of innovative curricula

The development of innovative curricula is crucial to respond to these challenges, and paramount to this innovation is a change of lenses and logic: a change of paradigm. This new paradigm should: 1) Strengthen its focus in the co-creation of knowledge and innovation with all stakeholders (Wals, 2015); 2) Follow a cycle of analysis, design, development, implementation, and evaluation (Shinn, Navarro, & Briers, 2015); 4) improve cooperation, efficiency, adaptation, and agility (Meinke, Batt, McKenzie, Bonney, Pratley, & Botwright Acuña, 2015); and 4) lead innovation through both incremental optimization and transitions (change the way we think) (Wals, 2015).

To this end, Higher Education should foster institutional changes and promote a curricular reform that changes what we do and how we do it (learning goals, teaching and learning methods, course structure, program operations, course content, and materials).

4. Institutional changes

Regarding the necessary institutional changes, participants suggested that some possible strategies included the following: 1) Forge public/private relationships, and collaborate with pre-degree institutions, between faculties and institutions, globally; 2) Integrate multiple actors and strengthen collaboration between all stakeholders in education (educators, learners, scientists, communities, government, private sector, organizations, individuals, consumers, producers); 3) connect diversity to teaching and learning processes; 4) Focus on science for society, and treat science/education as a "community" (Wals, 2015); 5) Rebrand, improve, and broaden image to attract more and high quality students: Consider characteristics, background, interests, motivations, and concerns of students (including social awareness and commitment); expand presence (i.e., social media); broaden programs; promote the important role of the bioeconomy and its impact to society (which is important to new generations of students), and promote high employability and quality of education (Meulendijks, 2015); 6) Expand processes to support educational improvement: Focus on new competencies for educators (increase focus on teaching skills, relevance, competency, and flexibility), include teaching quality in promotion considerations, and increase resources to provide professional development and teaching support for educators (i.e., establish university teaching and learning centers); 7) Improve quality assurance and programme accreditation processes (improve indicators, data collection, tools, and processes) (Shinn, Navarro, & Briers, 2015); 8) Introduce place-based institutional sustainability practices (walking the talk: experimenting with, and learning from creating sustainability on location) (Wals, 2015); 9) Participate in non-traditional education models through ICT (i.e., open universities, online courses, open education resources, MOOCs) (Kanwar, 2015); and 10) Strengthen Extension and outreach educational roles.

5. Curricular reform

Many of the discussions and messages from the presentations focused on much needed curricular reforms to innovate and increase impact, relevance to society, rigor, access, efficiency, and quality of higher education in the bioeconomy. To do that, there were suggestions to improve operational and structural aspects of the curriculum (teaching and learning methods, grouping of students, place and time of learning), as well as formal aspects of the curriculum (course content and materials).

A. Operational and structural aspects of the curriculum

To improve operational and structural aspects of the curriculum, suggestions focused on the following: 1) Improve teaching and learning methods by enhancing pedagogical methods (i.e., increase learner-centered focus, experiential and problem-based learning) and engaging students **in** the issues, not by teaching about the issues; 2) Promote authentic and social learning.

Blend formal, informal, and non-formal learning; peer-to-peer, mentorship and apprenticing. Expand internships and blur boundaries between institutional, community-based, and workplace (industry, government, non-profit) learning. Engage students in extra-curricular learning experiences; and 3) Develop mobility programs (from exchange programs to joint degrees between educational institutions) (Van Huylenbroeck & Dewulf, 2015); and integrate information and communication technologies (inverted, blended, online) (Meinke et al., 2015).

B. Formal aspects of the curriculum

A score of suggestions were made regarding improvements to the formal aspects of the curriculum, namely, the course content and materials. A key suggestion that transpired throughout the conference was the **need to diversify and increase focus on the bioeconomy and sustainability.** The bioeconomy encompasses the production of renewable biological resources and the conversion of these resources and waste streams into value added products, such as food, feed, bio-based products and bioenergy. The bioeconomy must be managed with due regard to environmental and social sustainability.

Another key theme, the need to redefine learning outcomes to develop "wiser" students, was largely discussed, countered with even more questions, and received with a mix of enthusiasm and reluctance. To some, their institutions had already addressed such reform, to others, while imperative, there were still many barriers to overcome. Questions surrounding this theme included the degree of change that was needed (how much?), the distribution of responsibilities (who? – instructors, students), the process (how?), and the format (where? – in additional courses, integrated across the curriculum, in internships).

Some of the issues involving the redefinition of the learning outcomes included the following: 1) Increase focus on higher order learning skills (critical thinking, analysis, evaluation, synthesis); 2) Develop graduates who can deal with complexity, are holistic thinkers and effective problem solvers; 3) Extend Bloom's taxonomy by adding a capability extension (motivation, capability, and self-belief) and creativity (Allan & Rowsell, 2015); 4) Integrate, or converge, other disciplines with life sciences. Move toward systems thinking and transdisciplinary learning; 5) Increase reflection, social science focus (impact in society, values, professional responsibility, etc.), and human capacity development (Asanuma, 2015); 6) Support students' development of communication, interpersonal, self-management, teamwork, leadership skills (also framed by many as "soft skills"), as well as innovativeness and entrepreneurship skills (Zaglul, 2015); 7) Provide students with a framework to examine ethical issues, as well as with experience in analyzing these issues (Knauft, 2015); 8) Balance breadth and depth of knowledge, specialization, and outward orientation, to understand whole systems; and 9) Focus on life long learning or job skills? Prepare generalists or specialists? Technicians, engineers, or scientists?

For some, there was also an urgent need to continue research to examine the trends, and improve competencies, frameworks, and pedagogy in the higher education bioeconomy curriculum.

VI – Major outcomes/conclusions in terms of policy relevance

Much of the discussions focused on questions regarding what Higher Education needs to do to position itself to develop innovative, impactful, relevant, rigorous, accessible, efficient, and quality curricula. Key needs addressed included the following: 1) Better identify local, regional, and global challenges in agriculture and higher education that will help determine the curricular goals and changes necessary to meet future demands; 2) Shift from a focus in agriculture to a focus on the bioeconomy; 3) Change higher education's paradigm (a change of landscape requires a change of lenses) and implement institutional changes to support innovation and curricular reform; 4)

Examine competencies for the curriculum. Much emphasis was placed on the balance between breadth and depth of knowledge within disciplines, and on preparing graduates who have better communication skills, are holistic thinkers, and effective problem solvers; and 5) Enhance pedagogical methods toward a more learner-centered education, and promote authentic and social learning. While many participants indicated that their institutions were being successful, others agreed that a score of universities still had to address institutional, environmental, and human resource challenges to be successful in curricular reform, which called for research regarding the challenges/barriers and possible solutions to improving pedagogical methods and determining the changes needed in competencies addressed in the curriculum.

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